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EXECUTIVE SUMMARY

Florida Bay has been identified by the South Florida Water Management District (SFWMD) as a priority water body and the District has recommended that Minimum Flow and Level (MFL) criteria should be established for this Bay by 2006. Initial technical steps in the MFL process include: (1) identification of Florida Bay's resources and functions, (2) surveying available information, (3) documenting historic conditions, (4) synthesizing and analyzing data to determine relationships between freshwater inflow and ecological responses, with the purpose of identifying threshold conditions (freshwater flow, water levels, salinity) that impact Florida Bay natural resources, such that recovery requires at least two years. From this technical analysis, in conjunction with other technical and policy considerations, a definition of significant harm and associated numeric criteria will be developed. This report describes steps 1 through 4.

This document describes the District staff's evaluation of the relationships between the hydrologic conditions of the southern Everglades and the resulting ecological status of the salinity transition zone and northeastern Florida Bay. This report will be peer-reviewed by an independent panel of scientists. Results of the peer review process will be used to refine the technical evaluation, as appropriate, and the technical evaluation will ultimately be used in the rule development process for identification of a Florida Bay "Minimum Flow and Level" (MFL) standard.

RESOURCES IN THE FLORIDA BAY TRANSITION ZONE

This report focuses on northeastern Florida Bay and its adjacent salinity transition zone (**Figure E-1**) because this area is sensitive to managed freshwater flow and our current modeling capability is largely limited to this portion of the bay. This transition zone is characterized by a salinity gradient that ranges from predominantly fresh water and low salinity conditions at the northern boundary with Everglades marshes to predominantly marine waters at the southern boundary with northeastern Florida Bay. Most analyses in this report consider environmental conditions and ecological characteristics along a transect that extends from Taylor River at the upper (northern fresh water) edge of the transition zone, through a succession of brackish water channels and ponds in the saline wetlands, through a coastal embayment (Little Madeira Bay), to northeastern Florida Bay (Eagle Key Basin). This transect location was selected because it roughly follows a major path of freshwater flow delivered from the regional water management system into the northern end of Taylor Slough, toward the Taylor River and into Florida Bay. Furthermore, data availability is relatively high along this transect. The Taylor River site, located at the northern end of the transition zone – northeastern bay transect, was selected as representative of the low-salinity wetlands of the transition zone, and also as an indicator site for the entire transition zone – northeastern bay region.

A resource-based approach was applied to determine effects of reduced freshwater inflow and high salinity on plant and animal communities that live in the salinity transition zone and northeastern Florida Bay in order to identify thresholds that cause long term impacts (taking two years or more to recover to baseline character). Salinity along the study transect changes in response to local rainfall, upstream water management and water deliveries. A submerged aquatic vegetation (SAV) species, widgeon grass (*Ruppia maritima*), is identified as an important biological resource and an overall indicator of community health in this transition zone. Loss of SAV results in loss of habitat, shelter, and food for waterfowl, forage fishes and invertebrates; loss of productivity; destabilization of sediments; reduced nutrient retention; and water quality impacts throughout the transition zone.

Analysis of field data and results of modeling studies indicate that losses of all major SAV species and the ecological functions they serve are likely to occur in the transition zone when average salinity at the Taylor River site remains above 30 psu (practical salinity units) for periods of a month or more. SAV habitat in northeastern Florida Bay, downstream from the transition zone, is dominated by shoal grass (*Halodule wrightii*) and turtle grass (*Thalassia testudinum*). These species are more salinity tolerant than widgeon grass. Field and modeling studies also suggest that maintaining salinities less than 40 psu in northeastern Florida Bay prevents negative impacts, such as decreasing SAV species diversity, decreasing habitat quality, and decreasing fish and invertebrate resources. Based on these considerations, such impacts to resources across the transition zone and in northeastern Florida Bay will likely occur when average monthly salinity at the Taylor River site exceeds 30 psu. Long term impacts occur when monthly average salinity exceeds 30 psu during consecutive years.

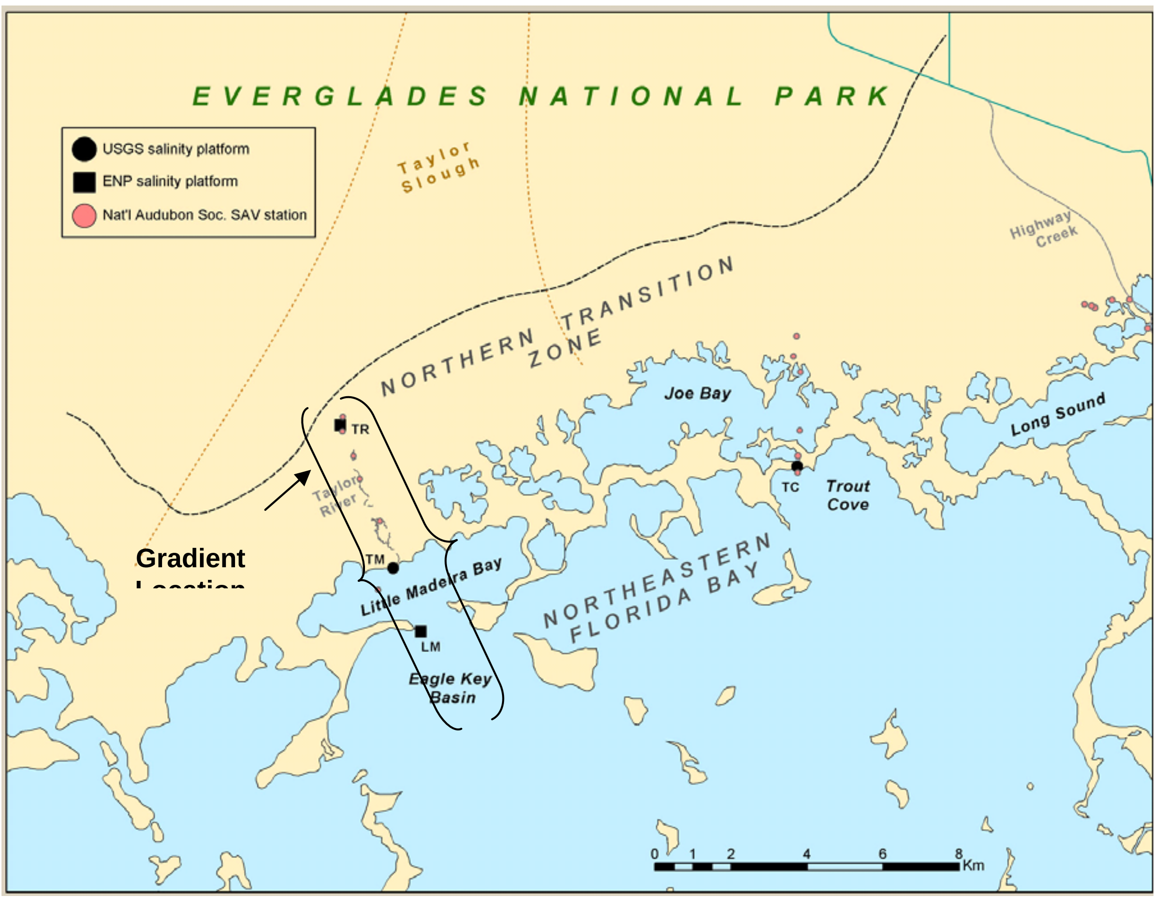

Figure E-1. Location and major features of northeastern Florida Bay showing: locations of Taylor River, Taylor Slough and other creeks that flow across the transition zone.

DATA ANALYSIS AND OCCURRENCES OF RESOURCE IMPACTS

A mass balance hydrologic model (FATHOM) was used in conjunction with field salinity measurements to simulate a 33-year historical record of inflows (1970-2002) and corresponding salinities for Florida Bay. In addition, a statistical multiple linear regression (MLR) model was developed and used in combination with field data to determine relationships among surface water levels, flow, and salinity in the transition zone and estimate salinity conditions in the transition zone during a similar historical time period. This timeframe included both low-flow and high-flow periods, resulting from climatic patterns as well as structural and operational changes in the water management system. This analysis of historical conditions indicated that monthly average salinity conditions exceeded 30 psu during 12 years of this 33-year period at the Taylor River site (at the northern end of the study transect), including several times when these high salinity conditions occurred during two or more consecutive years. Further analyses were conducted to estimate the volume of fresh water that was discharged toward Florida Bay during, and prior to, periods when salinity would likely exceed 30 psu at the Taylor River site. Salinities generally exceeded 30 psu at this site during periods when (a) total annual flows entering northeastern Florida Bay were less than 105,000 acre-ft, and /or (b) monthly average salinities at Taylor River exceeded 19 psu during January to March and total freshwater flows for three consecutive months prior to the salinity exceedance were less than 7,000 acre-ft.

RECOVERY AND PREVENTION STRATEGIES

These analyses suggest that once the criteria for significant harm have been formally established through the MFL rule development process, a number of steps could potentially be taken by water managers to decrease the occurrences of high salinity conditions (above 30 psu) at the Taylor River site. These actions will be defined in the final rule and technical documentation in terms of recovery strategies (if the MFL criteria are being exceeded under current conditions) or prevention strategies (if the MFL criteria are likely to be exceeded in the future).

As part of a continuing adaptive management program for this region, upstream flows, water levels and salinity at the Taylor River site, and SAV resources along the transect, should be continually monitored. Fresh water flows through the transition zone during very dry periods can potentially be managed to reduce or prevent high salinity conditions by providing additional water deliveries to Taylor Slough when sufficient good quality water is available. Future planning efforts and field tests should evaluate the feasibility and/or need for additional regional storage that may be needed to provide these increased flows.

CONCLUSIONS

- Submerged Aquatic Vegetation (SAV) habitat within the Taylor River/Little Madeira Bay/ Eagle Key gradient is responsive to conditions in the Everglades–Florida Bay Transition Zone; SAV is a critical component of the Florida Bay ecosystem.
- Freshwater discharges from the regional water management system have a direct effect on salinity conditions in the transition zone and also influence adjacent waters of northeastern Florida Bay.
- Widgeon grass *(Ruppia maritima)* is an indicator of SAV habitat and ecosystem status. *Ruppia* is responsive to salinity change in the transition zone and, compared to other SAV species in this zone, is tolerant of high salinity; when *Ruppia* is eliminated by high salinity, SAV habitat is lost. A threshold condition averaging above 30 psu for 30 days during two consecutive years is identified as a condition that causes a long term (requiring at least two years for recovery) impact on *Ruppia* and the ecosystem.
- High salinity conditions that cause loss of SAV in the transition zone results in loss of other resources and functions including loss of habitat; decreased productivity and food for waterfowl, forage fishes and invertebrates; destabilization of sediments; and reduced nutrient retention and water quality throughout the transition zone.
- Review of salinity relationships developed in the report shows that the freshwater flows needed to maintain the a salinity regime of less than 30 psu in the transition zone will also

sustain variable estuarine salinities less than 20 psu during the wet season and salinities less than 40 psu during the dry season in northeastern Florida Bay.

- The loss or degradation of ecological resources and functions in the transition zone and northeastern Florida Bay can be minimized by providing sufficient fresh water flow, including discharges from regional water management facilities that maintain monthly salinity at the Taylor River site below 30 psu.
- Historical conditions over a 33-year period from 1970-2002 were reconstructed using a combination of model simulations and field data to estimate how often monthly average salinity exceeded 30 psu at the Taylor River monitoring site. Results of this analysis also provide a basis for comparison with proposed future recovery or prevention strategies, operational changes and/or restoration plans.
- Periods when monthly average salinity at Taylor River exceeded 30 psu generally corresponded to regional droughts or prolonged periods of low flow conditions. Over a 33-year period of reconstructed salinity conditions, 12 years had at least one month with an average salinity at Taylor River above 30 psu. Over this 33-year period, there were six periods when these high salinity conditions occurred in two or more consecutive years.
- High salinities (> 30 psu) generally occurred in the transition zone during periods when salinities at the Taylor River site were elevated (19 psu or higher) at the beginning of the calendar year, local rainfall was below normal and total freshwater flows were reduced.
- This analysis also showed that during periods when monthly average salinity at the Taylor River site exceeded 30 psu during successive years, salinity downstream in Little Madeira Bay and Eagle Key Basin were considerably higher and persisted for much longer periods. When salinities at Taylor River during drought periods exceeded 30 psu for 2-5 months, salinities in Little Madeira Bay and Eagle Key remained above 30 psu for a year or more and were above 40 psu (hypersaline) for several months.
- The relationships defined in this document provide quantitative information that can be used to help define flow conditions that are likely to result in significant harm to resources in the Everglades–Florida Bay Transition Zone and adjacent waters of northeastern Florida Bay.
- The volumes, spatial distribution and seasonal timing of inflows to northeastern Florida Bay should be included as elements to be further investigated in the Florida Keys and Florida Bay Feasibility Study (FBFKFS) and projects associated with the Comprehensive Everglades Restoration Plan (CERP).
- Any proposed MFL should be evaluated for consistency with existing and proposed MFLs for other water bodies within the regional system, including Everglades National Park.
- The District should continue support for ongoing investigations to gain a better understanding of the relationships between water levels at various sites in the Everglades, C-111 Basin and Florida Bay salinity.
- Conclusions from this investigation should be further refined and tested with newer and better data and modeling tools as these become available.
- Effects of salinity exposure on SAV, fishes and invertebrates need further investigation
- Monitoring of flow, salinity and the response of submerged aquatic vegetation and animal communities in the Taylor River and adjacent waters of northeastern Florida Bay should continue.

TECHNICAL SUMMARY

The Lower East Coast Regional Water Supply Plan identified Florida Bay as a priority water body for development of Minimum Flow and Level (MFL) criteria. In 2005, the MFL Priority List was updated to indicate that MFL criteria for Florida Bay would be established in 2006. This document summarizes technical analyses conducted by the SFWMD to support the development of MFL criteria for northeastern Florida Bay. Initial technical steps in the MFL process include: (1) identification of Florida Bay's resources and functions, (2) surveying available information, (3) documenting historic conditions, and (4) synthesizing and analyzing data to determine relationships between freshwater inflow and impacts on the Bay's resources for the purpose identifying threshold conditions (freshwater flow, water levels, salinity) that impact Florida Bay natural resources, such that recovery requires at least two years. From this technical analysis, in conjunction with other technical and policy considerations, a definition of significant harm and associated numeric criteria will be developed. This report describes scientific information that comprises steps 1 through 4.

Florida Bay is a shallow estuary (average depth <1 meter) at the extreme southern end of the Florida peninsula, bounded on east and south by the islands of the Florida Keys, on the north by the Everglades, and on the west by an open-water interface with the Gulf of Mexico. The bay is largely within Everglades National Park and located in Miami-Dade and Monroe counties. The interior of the Bay is dominated by a complex array of small islands, mud banks, and seagrass beds that restrict circulation of water. The primary sources of freshwater input to northeastern Florida Bay are rainfall and flow from the Everglades watershed, including discharges from the regional water management system, through a major slough system (Taylor Slough), adjacent wetlands of the southeastern Everglades (the C-111 Canal basin), and tidal creeks.

Despite a history of research and monitoring activities within Florida Bay, quantitative information directly linking the responses of Florida Bay biota to changes in salinity or freshwater inflow had not been synthesized at the onset of this MFL effort. Several studies were therefore initiated to accomplish technical analyses supporting MFL development. These studies focused on resources within northeastern Florida Bay that are influenced by water management activities. A mass-balance hydrologic model, statistical flow/salinity relationships in the transition zone, a dynamic seagrass model, and statistically-based higher trophic level species models were enveloped. Data collection will continue and models will be further developed over the next several years in support of the Comprehensive Everglades Restoration Plan (CERP), including the Florida Bay and Florida Keys Feasibility Study (FBFKFS), which are evaluating the restoration needs of the Bay. These efforts will also provide greater predictive capability for future MFL evaluations.

This report provides a description of the water body (Chapter 2), the resources that need to be protected (Chapter 3), relationships that were used to define resource impacts (Chapter 4), how these relationships can be used to help develop MFL criteria (Chapter 5).

APPROACH

A number of possible approaches and options were considered as a means to support the development of MFL criteria for Florida Bay. A resource-based approach was applied, using a submerged aquatic vegetation (SAV) species, widgeon grass (*Ruppia maritima*), as an indicator of the salinity transition zone. This zone is defined as the wetland region between the Everglades and Florida Bay, where the fresh water of the Everglades mixes with the saline water of northeastern Florida Bay. Furthermore, this study utilized a gradient approach, evaluating environmental conditions and hydrologic-ecologic relations along a transect from the northern boundary of the transition zone into northeastern Florida Bay. The extent to which resources in the northeastern bay depend on an estuarine condition and the adequacy of a transition zone indicator (*Ruppia*) to protect the conditions in the Bay proper were also examined. The selected transect follows a major route of freshwater flow from the Taylor Slough, which receives water from the southeastern portion of the SFWMD canal system, to Florida Bay. Furthermore, monitoring of flow, salinity, and SAV along the transect has been ongoing as part of cooperative efforts among various Federal, State, and local agencies, along with universities and non-governmental organizations.

This report focuses on three regions along the Everglades–Florida Bay transect. The Taylor River site is representative of the northern transition zone, a region that commonly has fresh or olioghaline conditions and supports a mixture of biota, ranging from species common in the Everglades (e.g. sawgrass) to species common in Florida Bay (e.g. red mangrove). Little Madeira Bay is a representative coastal embayment that receives inflow from Taylor Slough, commonly has polyhaline to marine conditions, and supports a mixture of biota ranging from species common in the transition zone (e.g. widgeon grass) to species common in Florida Bay (e.g. turtle grass). The endpoint of the gradient is located within the Eagle Key Basin, which is representative of most of northeastern Florida Bay and contains SAV communities typical of the Bay as a whole (dominated by turtle grass). Salinity and biota in all three regions respond to freshwater inflow from creeks and overland sheet flow. Biological resources in fresh-to-brackish water portions of the transect are particularly sensitive to changes in freshwater inflow. The relationships among freshwater inflow, salinity, and impacts to resources were used to identify threshold flow and salinity levels that correspond with long term impacts to SAV.

A statistical (multiple linear regression) model was used to estimate the relationship between Everglades water levels and salinity in the transition zone. Additionally, a mass balance model (FATHOM) was used to simulate historical inflows and salinity responses in northeastern Florida Bay. Both modeling approaches, combined with available historical field data, were used to reconstruct salinity conditions during a 33-year time period (1970-2002) that includes both drought conditions and changes in water management in the basin. Results of these analyses identified those periods when elevated salinity conditions and impacts to SAV resources historically occurred within the transition zone and the associated salinity conditions in northeastern Florida Bay. The effects of these salinity conditions on seagrass and animal species in northeastern Florida Bay were then assessed using a combination of available field observations and predictive ecological modeling tools.

RESOURCES ALONG THE GRADIENT

The Everglades–Florida Bay transition zone is an ecotone containing numerous creeks, ponds, lakes, and wetlands that include mangrove swamps and saline marshes. Hydrologic conditions in this zone are influenced by sheet flow and seepage of fresh water from the Everglades and by intrusion of saline water from Florida Bay, as driven by wind and tide.

Wetlands at the boundary of the Bay, and bordering numerous mangrove creeks and ponds within about five kilometers of the Bay, are dominated by *Rhizophora mangle* (red mangrove) trees. Toward the interior of the transition zone, marshes contain a mixture of mangrove shrubs and grasses. Much of this zone has low productivity and sparse vegetation. *Cladium jamaicense* (sawgrass) dominates the freshwater boundary of the transition zone.

Transition zone wetlands provide habitat for the endangered American crocodile, which relies on the presence of estuarine conditions for part of its life cycle. These wetlands are also important foraging areas for various species of mammals such as raccoons, and for wading birds, such as the roseate spoonbill. Studies in the transition zone wetlands have shown that the density and biomass of forage fish tend to decrease during periods with low water levels and high salinities and increase with longer, more stable hydroperiods and reduced salinities. Foraging success of wading birds is highly dependent on declining water levels in the early dry season, which concentrate prey for these birds.

Aquatic biological communities that occur along the salinity gradient within the Everglades–Florida Bay transition zone include SAV communities that range from freshwater species such as bladderwort (*Utricularia* spp.) to oligohaline species (dominated by widgeon grass, *Ruppia maritima*) in transition zone ponds. Mixed seagrass (dominated by shoal grass, *Halodule wrightii* and turtle grass, *Thalassia testudinum*) are found in the northeastern coastal embayments and Florida Bay, proper. Within freshwater-to-oligohaline sections of the transition zone, widgeon grass is the predominant dominant vascular plant in the SAV community. These plants support an abundance of fish and invertebrate species that depend on the vegetation for food and shelter.

Within the more saline regions of northeastern Florida Bay, shoal grass and turtle grass become the dominant SAV species. Seagrasses are not only a highly productive foundation of the food web, but are also a principal habitat for higher trophic levels and a controller of water quality. Seagrass provides refuge, spawning or nursery area, and a food source for numerous important fish and invertebrate species. Spotted sea trout (*Cynoscion nebulosus*), gray snapper *(Lutjanus griseus*), red drum (*Sciaenops ocellatus*), snook (*Centropomus undecimalis*), striped mullet (*Mugil cephalus*), bay anchovy *(Anchoa mitchelli*), and a variety of forage fishes are permanent or transient residents in Florida Bay. Pink shrimp (*Farfantepenaeus duorarum*) and the spiny lobster (*Panulirus argus*) use much of Florida Bay as a primary nursery ground.

The SAV community along the gradient from Taylor River to Eagle Key Basin is a critical component of the regional ecosystem. This community includes a diversity of species, the most prominent of which are widgeon grass, shoal grass and turtle grass. These SAV species support key ecological functions of the Florida Bay estuarine ecosystem; they provide habitat, shelter, and food for waterfowl, forage fishes and invertebrates; primary and secondary productivity; substrate stabilization; nutrient retention; and water quality benefits.

DETERMINING EFFECTS OF SALINITY ON FLORIDA BAY RESOURCES

The technical information presented in Chapter 4 will be used as a basis to help define “significant harm” and appropriate water level and flow criteria to prevent significant harm. This technical information base is derived from literature reviews, field data and observations, small scale and mesocosm experiments, and numerical modeling. Two types of seagrass models (statistical and dynamic) were used to assess responses of indicator SAV communities over the historical period. Widgeon grass (*Ruppia maritima*) was selected as an indicator species for the transition zone and links were defined between the health of this species, the condition of the overall SAV community at the northern end of the transition zone and effects on downstream coastal embayments and seagrasses in Florida Bay. *Ruppia* is the most salt-tolerant SAV species in the transition zone. When salinity concentrations are too high to support *Ruppia*, then the entire SAV community in the transition zone, the habitat function provided by this community, and the associated plants and animals that depend on this habitat are also lost. Impacts are also likely to occur in marine seagrass communities located further downstream in northeastern Florida Bay.

Empirical evidence suggests that *Ruppia* is eliminated from transition zone waters when salinity exceeds 30 psu for about 30 days. This loss of *Ruppia* is likely due to mortality of seedlings and adult plants, as well as inhibition of seed germination and reproductive success above this salinity level. A threshold condition averaging above 30 psu for 30 days during two consecutive years is identified as a condition that causes a long term impact on *Ruppia* and the ecosystem.

Results of laboratory, modeling and field studies indicate that in the coastal embayments and open waters of northeastern Florida Bay, turtle grass (*Thalassia)* is likely to become dominant under sustained hypersaline conditions (above 40 psu), whereas shoal grass (*Halodule*) becomes dominant under sustained mesohaline conditions (less than 18 psu). The quantitative and qualitative composition of the SAV community, in turn, may impact many fish and invertebrate species within Florida Bay. Ecological models were used to characterize the sensitivity of various animals to salinity and to habitat quality within northeastern Florida Bay. Recent literature and research were reviewed to characterize organisms that used these zones and their salinity tolerances. Model analyses were then performed to assess the combined effects of salinity and changes in SAV habitat on animal assemblages. Salinity has a significant (though widely varying) effect on these species. Most of these fauna benefit from increased SAV cover. Analyses indicate that as salinity in the Bay increases from mesohaline toward marine and hypersaline conditions, overall abundance of the forage base (small animals that are food for larger fish, particularly sport fish) decreases. These changes occur due to direct salinity effects on fauna and indirect effects of SAV habitat loss. In particular, results indicate that the qualitative composition of SAV habitat affects higher trophic level species; loss of *Halodule* with prolonged hypersalinity appears to be detrimental to the faunal assemblage. Maintaining estuarine salinity (less than marine levels) conditions will thus protect a higher quality SAV habitat and its associated animal communities.

FINDINGS RELEVANT TO SELECTING MFL CRITERIA

A minimum flow or level is defined by Ch.373.0421 (1) F.S. as “the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area”. In developing minimum flows and levels for water bodies within the jurisdiction of the District, the agency adopted a narrative definition of “significant harm.” Significant harm is defined in Ch 40E-8 F.A.C. as the temporary loss of water resource functions which result from a change in surface or ground water hydrology that takes more than two years to recover. The specific water resource functions addressed by a MFL and the duration of the recovery period associated with significant harm are defined for each priority water body based on the MFL technical support document and summarized in Chapter 40E-8.

The specific technical analysis under review focuses on relatively low flow and high salinity conditions and attempts to identify thresholds of salinity exposure that impact ecological structure or function of valued ecosystem components such that recovery of these attributes is likely to span at least two years. The purpose of the Technical Support Document is to document the scientific or technical concepts (including scientific strategies to determine MFLs), data, methodologies, assumptions, inferences, and conclusions that may ultimately be used to develop the proposed MFL criteria, based on the best available information.

The requirement that the level of resource impact associated with significant harm take more than two years to recover is a guide only, and is intended to indicate that “significant harm” is not an impact level that occurs under average or natural hydrologic conditions. Instead, “significant harm” refers to effects that occur during dry hydrologic conditions at a level and frequency as a result of man-made withdrawals that cause increasingly severe, cumulative effects on water resources, e.g. if an exceedance of the threshold condition reoccurs within an interval that is shorter than the time needed for that resource to recover.

In this technical report, resource impacts that can be used as the basis for defining significant harm and MFL criteria for Florida Bay were identified. Highlights of these findings include:

- SAV habitat within the Taylor River/Little Madeira Bay/ Eagle Key gradient is an important feature of the Florida Bay ecosystem that is influenced by freshwater discharges from the regional water management system.
- The availability and qualitative structure of this habitat are suitable indicators of the overall health of the entire transition zone and adjacent northeastern Florida Bay ecosystem.
- *Ruppia* is proposed as an indicator of the status of the transition zone for MFL determination. Impacts to *Ruppia* and other SAV resources occur when monthly average salinity exceeds 30 psu at the Taylor River site. Field and laboratory studies indicate that such a salinity exposure is associated with loss of *Ruppia* cover and SAV habitat in the transition zone.
- Long term impacts to *Ruppia* and SAV habitat are likely to occur when average salinity exceeds 30 psu for at least one month during consecutive years, thus preventing the resource from recovering to its pre-impacted condition. The duration and frequency of adverse salinity exposure impact the survival of the SAV community and associated organisms, as well as productivity, water quality water, and sediment stability in the Everglades–Florida Bay transition zone, unless adequate time is allowed for recovery.
- Review of salinity relationships developed in the report shows that the freshwater flows needed to maintain salinity below 30 psu in the transition zone will also prevent strong negative impacts to downstream SAV and other living resources in northeastern Florida Bay. These flows should sustain a variable estuarine salinity condition, with less than 20 psu during the wet season and less than 40 psu during the dry season in the northeastern bay.
- During periods when salinities in the transition zone are above 30 psu, salinities downstream in northeastern Florida Bay generally exceed 40 psu and may be considerably higher, representing a losses of estuarine conditions, habitat, productivity, and small forage organisms in this system.

OCCURRENCES OF RESOURCE IMPACTS

A model simulation was conducted to determine how often identified salinity thresholds have been exceeded under historical conditions. This analysis provides insights regarding the magnitude and frequency of environmental variability, causes of this variability (e.g. natural climatic versus water management), and those antecedent conditions that contributed to the current ecological status of this region. Model simulations used best available hydrologic and salinity data, historical operating facilities and procedures, and climate conditions to simulate historical conditions in the transition zone and Florida Bay for the period from 1970-2002. Model results from this simulation were then analyzed to identify periods when monthly average salinity conditions at the Taylor River site would have exceeded 30 psu.

Results based on the 33-year historical model run (1970-2002), indicated that the predicted monthly average salinities at the Taylor River site exceeded 30 psu during 12 years of the simulation period. This threshold was exceeded during two consecutive years during 1970-1971; for three successive years during 1973-1975; and for four successive years during 1989-1992. These periods generally corresponded to times when south Florida was experiencing extended regional droughts and/or onset of the subsequent wet season was delayed, resulting in elevated salinity conditions. This analysis also suggested that with current (post 1980) water management practices in place, some exceedances of the 30 psu salinity threshold in the 1970s may have been avoided.

Loss of *Ruppia* and SAV dependent species likely occurred in the transition zone during periods when monthly average salinities exceeded 30 psu in Taylor River, and likely became more severe as elevated salinities re-occurred during consecutive years. Changes in SAV diversity in northeastern Florida Bay likely occurred during such periods, with decreased *Halodule*, resulting in unstable conditions in the Florida Bay ecosystem, such as were seen during and after the 1989-1990 drought.

FLOWS AND WATER LEVELS DURING PERIODS WHEN RESOURCE IMPACTS OCCUR

The FATHOM model was used to simulate historic (1970-2002) salinity conditions in Florida Bay and estimate inflow of fresh water to Florida Bay during and prior to periods when average monthly salinities were above 30 psu at the Taylor River site. Periods when elevated monthly average salinities occurred during consecutive years under historical conditions generally corresponded to periods when the total annual inflow across the model boundary that represents input to northeastern Florida Bay was less than 105,000 acre-feet for two successive calendar years. A more detailed analysis of flows indicated that conditions with salinity exceeding 30 psu could occur even during years when the total annual flow to northeastern Florida Bay was greater than 105,000 acre-ft. Such conditions occurred when salinities in Taylor River during the period from January through March were above 19 psu and preceding 3-month total flows to northeastern Florida Bay were less than 7,000 acre-feet.

RECOVERY AND PREVENTION STRATEGIES

These analyses suggest that once the criteria for significant harm have been formally established through the MFL rule development process, a number of steps could potentially be taken by water managers to decrease the occurrences of high salinity conditions (above 30 psu) at the Taylor River site. These actions will be defined in the final rule and technical documentation in terms of recovery strategies (if the MFL criteria are being exceeded under current conditions) or prevention strategies (if the MFL criteria are likely to be exceeded in the future).

As part of a continuing adaptive management program for this region, upstream flows, water levels and salinity at the Taylor River site, and SAV resources along the transect, should be continually monitored. Fresh water flows through the transition zone during very dry periods can potentially be managed to reduce or prevent high salinity conditions by providing additional water deliveries to Taylor Slough when sufficient good quality water is available. Future planning efforts and field tests should evaluate the feasibility and/or need for additional regional storage that may be needed to provide these increased flows.

CONCLUSIONS

This document describes the District staff's evaluation of the relationships between the hydrologic conditions of the southern Everglades and resulting ecological status in the salinity transition zone and northeastern Florida Bay. This information will subsequently be used in the rule development process for identification of a Florida Bay “Minimum Flow and Level” (MFL) standard. Based on these analyses, the following conclusions are presented and discussed in this report:

- SAV habitat within the Taylor River/Little Madeira Bay/ Eagle Key gradient is representative of conditions in the Everglades–Florida Bay Transition Zone and is an critical feature of the Florida Bay ecosystem.
- Freshwater discharges from the regional water management system have a direct effect on salinity conditions in the transition zone and also influence adjacent waters within northeastern Florida Bay.
- Protection of transition zone and Florida Bay resources can be achieved by providing sufficient freshwater flow, including discharges from regional water management facilities, to maintain monthly average salinities less than 30 psu at the Taylor River monitoring site.
- A minimum annual discharge of 105,000 ac-ft into northeastern Florida Bay, as simulated by the FATHOM Model, is likely to maintain salinity below 30 psu at the Taylor River site. A three-month total flow of 7,000 ac-ft or greater may be needed during exceptionally dry periods (especially when January–March salinity is at or above polyhaline conditions (19 psu).
- These flows should result in salinity conditions that protect widgeon grass (*Ruppia*), SAV habitat, and associated resources along the transition zone gradient and protect seagrass communities and associated biota in northeastern Florida Bay.
- Analyses of reconstructed historic conditions suggest that the 30 psu monthly average salinity threshold is exceeded about once every three years (12 out of 33 years from 1970-2002) and that multi-year exceedances occur about once every six years.

The analyses presented in this report are based on best available information. The need for additional work is recognized. The following list summarizes limitations in the information presented and suggests future work.

- A monitoring program consistent with these recommendations and objectives should be instituted that includes salinity monitoring and periodic sampling of widgeon grass and other transition zone SAV.
- Research on the response *Ruppia* to salinity levels and variability, including effects on seed production, seed bank viability, and reproductive success should be implemented. The dynamic model of Florida Bay SAV should be expanded to include *Ruppia*.
- The habitat value of Ruppia and other SAV of the transition zone should be quantitatively assessed.
- These initial efforts to develop salinity-resource impact relationships for the Taylor River transect and northeastern Florida Bay should be expanded to include a broader area accounting for most coastal inflows to this region of the bay.
- Additional investigations should be initiated to determine effects of inflows from other coastal basins on salinity and resources in other areas of the Bay, including western Florida Bay, central Florida Bay, and Whitewater Bay.
- The spatial distribution and seasonal timing of inflow to northeastern Florida Bay should be included as elements to be further investigated in the FBFKFS and CERP projects. The proposed salinity and flow criteria should be included as system-wide performance measures and considered in projects and analyses that affect inflows.
- Relationships between water levels at various sites in the Everglades and C-111 basin and Florida Bay salinity (including central, southern, and western regions) should be investigated further. Analysis should include the use of improved hydrologic and hydrodynamic models that are being built for the FBFKFS (i.e. TIME

and EFDC models). Likewise, improved ecological models that may be produced as part of the FBFKFS or other projects should be applied to future analyses.

- The future with CERP project scenarios may result in a reduction in the occurrence of high salinity conditions in Taylor River and northeastern Florida Bay relative to current conditions. Additional analysis of the effects of CERP projects should be addressed by the FBFKFS.
- Any future Florida Bay MFL should be evaluated to ensure consistency with current Everglades MFL criteria. Since these criteria are based on stage, quantitative links need to be established among water levels, flows and salinities.
- As new information and modeling tools are developed or improved and/or modifications are made in the basin, the relationships between freshwater inflow, salinity conditions in the transition zone and northeastern Florida Bay and impacts to biological resources, should be reviewed and revised as needed.